

CLAIMS

What is claimed is:

1. A multi-channel communication system having a first station and a second station configured to communicate over two or more channels comprising:

5 the first station having two or more transmitters configured to send two or more transmitted signals over two or more channels from the first station to the second station;

the second station having two or more receivers configured to process a received signal, wherein each received signal comprises the transmitted signal and one or more coupling signals and wherein at least one receiver comprises:

10 a decision device configured to generate a decision output based on at least the received signal and a modified decision output;

a feedback system configured to generate the modified decision output and combine the modified decision output, the received signal, and one or more incoming FEXT cancellation signals;

15 an adder configured to add the modified decision output from the decision output to create an intermediate signal; and

one or more ELFEXT filters configured to process the intermediate signal to create one or more outgoing FEXT cancellation signals.

20 2. The system of Claim 1, wherein the communication system is further configured to transmit data from the second station to the first station.

3. The system of Claim 1, wherein the one or more incoming cancellation signals comprise one or more cancellation signals configured to remove FEXT coupling
25 from the received signal.

4. The system of Claim 1, wherein the adder is further configured to add the modified decision output and one or more incoming cancellation signals from the decision output to create the intermediate signal.

5 5. The system of Claim 1, wherein the ELFEXT filter is configured to account for an ELFEXT portion of FEXT coupling.

6. The system of Claim 1, wherein each receiver at the second station generates a unique cancellation signal tailored for each of the other receivers at the
10 second station.

7. The system of Claim 1, wherein the feedback system comprises a decision feedback filter.

15 8. The system of Claim 1, wherein the decision device comprises a slicer.

9. The system of Claim 1, wherein the multi-channel communication system comprises a four channel communication system configured to operate in accordance with an Ethernet Communication Standard.

20

10. The system of Claim 1, wherein the two or more transmitters of the first station further comprise two or more FEXT precode filters configured to modify the two or more signals prior to transmission to cancel FEXT coupling.

25 11. The system of Claim 10, wherein each transmitter comprises one or more FEXT precode filters configured to generate and provide one or more precode cancellation signals to other transmitters.

12. A multi-channel communication system configured to reduce noise comprising:

one or more transmitters configured to transmit a first signal on a first channel and
5 a second signal on a second channel; and

a first receiver configured to receive a third signal on the first channel and a
second receiver configured to receive a fourth signal on the second channel, wherein the
third signal comprises the first signal and a first interference component and the fourth
signal comprises the second signal and a second interference component wherein;

10 the first receiver comprises:

a first feedback filter loop configured to receive the third signal and reduce
interference on the third signal, the output of the first feedback filter loop
comprising a first feedback filter loop output;

15 a first decision device having a first decision device output configured as
part of the first feedback filter loop;

a first device configured to receive a second cancellation signal from the
second receiver and combine the second cancellation signal with the first
feedback filter loop output;

20 a first filter configured to receive at least the decision device output and
generate a first cancellation signal; and

the second receiver comprises:

a second feedback filter loop configured to receive the fourth signal and
reduce interference on the fourth signal, the output of the second feedback filter
loop comprising a second feedback filter loop output;

25 a second decision device having a second decision device output
configured as part of the second feedback filter loop;

a second device configured to receive the first cancellation signal from the first receiver and combine the first cancellation signal with the first feedback filter loop output; and

5 a second filter configured to receive at least the second decision device output and generate the second cancellation signal.

13. The system of Claim 12, wherein the first device and the second comprise summing junctions.

10 14. The system of Claim 12, wherein the first feedback filter loop and the second feedback filter loop both comprise a decision feedback filter configured to reduce intersymbol interference.

15 15. The system of Claim 12, wherein the multi-channel communication system has four channels and the interference comprises FEXT coupling.

20 16. The system of Claim 12, wherein the first filter and the second filter comprise digital filters having coefficient values selected to generate cancellation signals that cancel FEXT coupling.

25 17. The system of Claim 12, wherein the one or more transmitters further comprise precode FEXT filters, wherein each precode FEXT filter is configured to generate a cancellation signal that can be combined with a signal, prior to transmission of the signal, to pre-cancel FEXT coupling.

18. The system of Claim 12, wherein at least one of the one or more transmitters is configured to generate an outgoing precode cancellation signal and receive an incoming precode cancellation signal from another transmitter.

19. A receiver for use in a multi-channel communication system to cancel coupling on a transmitted signal and reduce intersymbol interference, wherein a distorted version of the transmitted signal and FEXT coupling comprise a combined signal, the receiver comprising:

5 a first device configured to receive and combine a feedback signal with the combined signal to create a decision device input signal;

a decision device configured to process the decision device input signal to generate a discrete output;

10 a decision feedback equalizer configured to receive and process the discrete output to generate an equalizer output;

a second device configured to combine an incoming cancellation signal with the equalizer output to create the feedback signal; and

15 one or more ELFEXT filters, each configured to generate an outgoing cancellation signal that is related to the discrete output, wherein the outgoing cancellation signal is tailored to cancel FEXT coupling on another channels in the multi-channel communication device.

20 20. The system of Claim 19, further comprising a third device configured to combine the discrete output and the one or more delayed cancellation signals to create an input to the decision feedback equalizer.

21. The receiver of Claim 19, wherein the decision device comprises a slicer having ten output levels.

25

22. The receiver of Claim 19, wherein each multi-channel communication system comprises a station and each station comprises four receivers.

23. The receiver of Claim 19, further comprising a feed forward filter configured to process the combined signal to reduce intersymbol interference on the combined signal.

5 24. A receiver in a multi-receiver system configured to receive two or more signals via two or more channels, each respective receiver comprising:

an input configured to accept a received signal;

a decision device configured to quantize a decision device input signal to one of two or more decision values, wherein the decision device input signal is based on the
10 received signal;

a first filter configured to process the decision values to create a first filtered signal;

one or more second filters configured to process the decision values and the first filtered signal to create an outgoing cancellation signal tailored to cancel coupling on one
15 or more other channels;

one or more devices configured to:

receive one or more incoming cancellation signals from other receivers in the multi-receiver system; and

process the one or more incoming cancellation signals, the first filtered
20 signal, and the received signal to cancel unwanted coupling in the received signal.

25 25. The receiver of Claim 24, wherein the first filter comprises a digital filter configured to generate a feedback signal that reduces intersymbol interference.

26. The receiver of Claim 24, wherein the decision device quantizes the decision device input signal to any one of ten values based on a comparison to predetermined thresholds.

27. The receiver of Claim 24, wherein the one or more second filters comprise digital filters having two or more coefficients and the one or more second filters and the first filter are configured to cancel coupling and reduce intersymbol interference.

5 28. The receiver of Claim 24, further comprising a third filter comprising a feed forward filter that is configured to process the received signal to reduce intersymbol interference.

29. The receiver of Claim 24, wherein the one or more devices comprise one
10 or more subtractors.

30. A method for reducing interference in a multi-channel communication system having two or more receivers and two or more channels, the method of the first receiver comprising:

15 receiving a first signal on a first channel with a first receiver and a second signal on a second channel with a second receiver;

combining a feedback signal with the first received signal to create a first combined signal;

processing the first combined signal to reduce intersymbol interference in the first
20 combined signal to create a processed signal, the interference created by passage of the first signal through the first channel;

combining the processed signal with at least a first cancellation signal received from at least the second receiver to create a feedback signal;

combining the feedback signal with the first combined signal to create a second
25 combined signal; and

processing the second combined signal to generate at least a second cancellation signal.

31. The method of Claim 30, wherein the combining a feedback signal with the first received signal cancels FEXT coupling in the first received signal.

32. The method of Claim 30, wherein processing the first combined signal
5 comprises performing decision feedback equalization on the signal to generate a signal that reduces intersymbol interference.

33. The method of Claim 30, wherein processing the second combined signal to generate at least a second cancellation signal comprises filtering the second combined
10 to isolate ELFEXT coupling.

34. The method of Claim 30, wherein the second receiver is configured similarly to the first receiver and the second receiver generates the first cancellation signal and receives the second cancellation signal from the first receiver.
15

35. The method of Claim 30, further comprising delaying the first cancellation signal to achieve proper timing.

36. A receiver for FEXT cancellation in a multi-channel communication
20 system comprising:

a feedback loop comprising:

a first device configured to combine a received signal with a feedback signal and one or more incoming cancellation signals to create a combined signal;

a decision device configured to process the combined signal to generate a
25 decision output;

a first filter configured to generate the feedback signal based on the decision output and the one or more incoming cancellation signals or a delayed version of the one or more incoming cancellation signals, wherein the one or more

incoming cancellation signals are received from one or more other receivers in the multi-channel communication system; and

one or more second filters configured to receive at least the decision output and generate one or more outgoing cancellation signals which are routed to other receivers in the multi-channel communication system.

37. The receiver of Claim 36, wherein the first device comprises a subtractor or summing junction, the first type filter is configured to account for the effects of the channel and the one or more second type filters are configured to account for coupling.

38. The receiver of Claim 36, wherein FEXT cancellation is performed by the first filter and an incoming cancellation signal.

39. The receiver of Claim 37, further comprising a feed-forward filter configured to process the received signal prior to the received signal arriving at the feedback loop.

40. The receiver of Claim 37, wherein a receiver is associated with each channel in a four channel communication system and each receiver receives an incoming cancellation signal from each of the other receivers.

41. A method for canceling coupling in a multi-channel communication system having two or more receivers comprising:

receiving a signal over a channel;

receiving at least one cancellation signal from at least one of the other receivers in the multi-channel communication system;

processing the signal to account for the effect of the signal passing through the channel thereby generating a processed signal;

combining the processed signal and the one or more cancellation signals from the other receivers to generate a feedback signal;

combining the feedback signal with the received signal to cancel coupling in the received signal; and

5 generating one or more outgoing cancellation signals as a result of processing the processed signal and providing at least one outgoing cancellation signals to at least one of the other receivers in the multi-channel communication system.

42. The method of Claim 41, wherein generating one or more outgoing
10 cancellation signals comprises generating one or more cancellation signals with a filter configured to isolate the ELFEXT coupling.

43. The method of Claim 41, further comprising combining the feedback
signal with the one or more cancellation signals from the other receivers prior to
15 combining the feedback signal with the received signal to reduce noise in the received signal.

44. The method of Claim 41, wherein processing comprises processing with a
decision feedback equalizer.

20

45. The method of Claim 44, wherein processing further comprises quantizing
the combination of the received signal and the one or more cancellation signals to one of
one or more discrete levels prior to processing.

25 46. A system for canceling one or more FEXT signals that have coupled onto a transmitted signal to create a modified signal in a multi-channel communication device comprising:

means for receiving the modified signal over a channel in the multi-channel communication system;

means for combining the modified signal with a feedback signal to isolate the transmitted signal;

5 means for generating the feedback signal comprising:

means for filtering the isolated transmitted signal to create a filtered signal;

means for receiving and combining the filtered signal and one or more cancellation signals received from other receivers in the multi-channel communication device; and

10 means for generating one or more cancellation signals to be outputted to one or more other receivers.

47. The system of Claim 46, wherein means for generating comprises a decision device and a filter.

48. The system of Claim 46, wherein the means for generating one or more cancellation signals comprises:

means for combining the transmitted signal and the feedback signal to create a cancellation filter input signal, and

means for processing the cancellation filter input signal to create cancellation signals to be provided to other receivers.

25